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Millet Marvels: Banyard &Foxtail Tikki Treat

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ABSTRACT

Foxtail millet is one of the oldest cultivated millets in the world. It is a nutrient-dense, gluten-free, and drought-resistant super grain that thrives in arid climates. It originated from China and is popular in Asia and Africa, it is increasingly used as a healthy alternative to rice and wheat due to its high fiber and protein content. Barnyard millet is an ancient, fast-growing small-seeded cereal crop recognized as a "super grain" due to its exceptional nutritional profile. It is often used as a substitute for rice, particularly during religious fasting, because it is nutritious, light to digest, and naturally gluten-free. Traditionally, tikki is prepared using potatoes along with maida, rice flour, and corn flour. The study aimed to improve the nutritional quality of Tikki by incorporating nutrient rich foxtail millet and barnyard millet. Three different Tikki variants were prepared using various combinations of these ingredients. The present study aimed to develop millet-based tiki and evaluate its sensory and nutritional properties. Four formulations, including a control and three millet-incorporated samples, were prepared and analyzed. Sensory evaluation using a 9-point hedonic scale indicated good acceptability, with the foxtail millet sample (S1) scoring highest (7.78). Proximate analysis showed increased fiber (up to 11.21%) and ash content (5.23%) in millet-based samples, along with reduced fat content compared to control. The developed product demonstrates potential as a healthy, low glycemic snack option for health-conscious consumers.

Key words: Foxtail, Tikki, Barnyard, foxtail millet,Vegetable mix

INTRODUCTION

Millets are a group of small-seeded cereal grains that include several important species such as pearl millet (Pennisetum americanum), foxtail millet (Setaria italica), proso millet (Panicum miliaceum var. compactum), and finger millet (family Gramineae) [1] . Among these, commonly cultivated varieties include foxtail millet (Setaria italica) and barnyard millet (Echinochloa frumentacea). Foxtail millet is one of the earliest domesticated crops, with its origin traced to China, and it is presently cultivated across various regions of the world. It is distinct from other cereal crops in terms of its morphological, textural, and nutritional characteristics and is highly drought resistant and tolerant of poor soils. In recent years, growing awareness of healthy eating habits has renewed interest in cereal-based foods, including foxtail millet [2].

Barnyard millet is cultivated in several regions, including India, Japan, China, Malaysia, the East Indies, parts of Africa, and the United States. It is a fast-growing crop that

can produce mature grains within about 45 days of sowing. Owing to its ability to thrive under sub-marginal soil fertility and low moisture conditions, barnyard millet is well suited for cultivation in areas where major cereal crops fail to achieve satisfactory yields [3,7].

Foxtail millet and barnyard millet are gluten-free, nutrient-dense whole grain food. Compared with rice and wheat, they contain higher levels of protein along with a wide range of vitamins and minerals. These millets also have a lower glycemic index than staple foods made from rice or wheat flour. In addition, the presence of bioactive polyphenols in foxtail millet has been associated with supportive effects in the management of diabetes, cancer, and cardiovascular diseases. Consequently, millets exhibit significant potential for use in functional food applications [4,8].

The traditional processing methods for millet are relatively simple but time-consuming; therefore, the development of convenient foxtail millet–based foods has become a major focus of current research [5]. However, the low gluten content of foxtail and barnyard millet limits their dough-forming and processing properties compared with wheat. As a result, most millet-based products are formulated by blending foxtail or barnyard millet flour with other raw materials rather than using millet flour alone [5].

At present, numerous millet-based products such as noodles, biscuits, bread, beverages, and instant powders have been widely studied. Therefore, present study was undertaken to prepare tikki by incorporating millets such as foxtail and barnyard. Tikki is traditionally prepared using ingredients like potatoes and rice flour; however, the inclusion of foxtail and barnyard millets enhances its nutritional value. The developed millet tikki serves as a healthier snack option with improved fibre and protein content, while also being gluten-free. The aim is to evaluate its sensory quality and acceptability by diabetic subjects. The nutritional value and glycemic index of the tikki were also assessed.

Materials and methods:

1. Collection and processing of Raw Materials:

Foxtail millet, barnyard millet grains, refined wheat flour and rice flour were purchased from a local market, Alwal, Hyderabad. The grains were cleaned free from dust and foreign particles. The foxtail millet grains were first soaked in water for one hour. After soaking, the excess water was removed and the grains were spread on a clean kitchen towel or paper towel to dry for about 15–30 minutes. The partially dried grains were then tray-dried at 60 °C until they reached an appropriate dryness for milling. Finally, the dried millet was ground into fine foxtail millet flour (FMF) and barnyard millet flour (BMF) in a commercial roller mill [6].Thereafter it was passed through a 20 mesh sieve in order to obtain the flour for the study.

Foxtail millet grains, barnyard millet grains, refined wheat flour, rice flour.

2. Formulation of product:

Four product formulations were prepared for the study. Sample D served as the control and was prepared using only refined wheat flour (maida) and rice flour. In Sample A, foxtail millet flour was incorporated along with refined wheat flour and rice flour. Sample B was prepared by adding barnyard millet flour to refined wheat flour and rice flour. Sample C contained a

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combination of foxtail millet flour and barnyard millet flour along with refined wheat flour and rice flour. Table 1 shows the formulation of 4 product samples.[Table 1]

Table 1: Formulation of products

INGREDIENTS	SAMPLE A	SAMPLE B	SAMPLE C	CONTROL
Foxtail millet	**75 gm**	**-**	**60 gm**	**-**
Barnyard millet	**-**	**75 gm**	**60 gm**	**-**
Rice flour	**50 gm**	**50 gm**	**40 gm**	**100 gm**
Refined wheat flour	**75 gm**	**75 gm**	**40 gm**	**100 gm**

3. Product preparation:

For the tikki production, we have blended flours of foxtail, barnyard, refined wheat and rice flour in the ratio's of 1:1:½ :½ . In the present study, we have produced 4 samples of different formulations.

For sample A, we have used Foxtail millet along refined wheat flour and rice flour. For sample B, we have used barnyard millet and for Sample C, we have used both foxtail and barnyard millets. Sample D was taken as control, we have used refined wheat flour and rice flour.

The other ingredients used were: grated carrots, sweet potato which was boiled and grated, chopped onions, curry leaves, coriander leaves, green chillies and ginger garlic. All ingredients were thoroughly mixed to form a uniform dough. The prepared dough was divided into portions, shaped into balls, and flattened into tikkis. The tikkis were then shallow-fried or air-fried for a few minutes under required conditions. [Figure 1 (a&b),2]

Fig.1 (a)

Fig.1(b)

Fig.1 (a) &(b) Millet tikki prepared in air-fryer

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Fig. 2 Millet tikki

Product preparation flow sheet:

Collection of millets

[Foxtail and Barnyard millet]

↓

Soak the millets [1-2hours]

↓

Drain excess water

↓

Dry the millets in the tray drier (60°C)

↓

FMF and BMF

↓

Add rice flour (RF) refined wheat flour (RWF)

↓

Add grated carrot

Chopped onions, green chillies & ginger garlic

Chopped coriander & curry leaves

↓

Dough formation

↓

Flattened to tikki shapes

↓

Shallow fry [temperature 120C]

↓

Millet tikki

4. Sensory analysis :

Sensory evaluation was performed using a 9 point hedonic scale with 10 panelists. The panelists were instructed with details on scoring with a 9 point hedonic scale, where 1 = Dislike extremely and 9 = Like extremely. The formulated samples and a control sample was analysed for following parameters such as colour, flavour, texture and overall acceptability were rated according to the Table 2. The scores obtained reflect the degree of preference for the product's sensory qualities and help determine its consumer acceptability.

Table 2: 9 Point Hedonic Scale

Sample	Overall acceptability
Like extremely 9	
Like very much 8	
Like moderately 7	
Like slightly 6	
Neither like nor dislike 5	
Dislike slightly 4	
Dislike moderately 3	
Dislike very much 2	
Dislike extremely 1	

5. Proximate analysis:

All proximate analysis was done using standard protocols by using AOAC methods.[9,10,11]

5.1.Determination of Moisture content:

Moisture content was determined by initially weighing the samples, drying them in a hot air oven at 105 °C for 1 hour, and subsequently reweighing them after cooling to room temperature [9].

5.2. Determination of ash content:

Pre-weighed crucibles were taken and the samples were placed in them. The samples were initially ignited until a grey residue was obtained, followed by incineration in a muffle furnace at 550 °C for 3–4 hours. After cooling to room temperature, the ash samples were weighed [9,10,11].

5.3. Determination of fat content:

Fat extraction was carried out using the Soxhlet extraction method. After 4 hours of extraction, the extracted fat was collected, and the flasks were placed on a rotary evaporator to remove the solvent. Any remaining solvent was further evaporated by heating at 103 °C for 30 minutes. The flasks were then cooled to room temperature in a desiccator and weighed. [9, 10]

5.4. Determination of crude fibre content:

To determine fiber content, a known weight of the sample is first defatted and then subjected to acid and alkali treatment to remove soluble carbohydrates, proteins, and other digestible components. The remaining insoluble residue, which is the crude fiber, is filtered,

dried, and weighed. The weight of this residue is then used to calculate the fiber content as a percentage of the original sample [10].

6. Results and Analysis:

After formulation and preparation of the tikki with varying concentration of millets along with control was analysed and the following results were obtained.

Table 3. Sensory evaluation of the samples

Sample	Appearance	Colour	Texture	Aroma	Taste	Overall
Control (S0)	7.5	6.2	8.2	8	8.8	7.74
S1	8	7	6.5	8.4	9	7.78
S2	6.5	8.4	7	8.2	8.2	7.66
S3	7	7.6	7.7	8.5	7.6	7.68

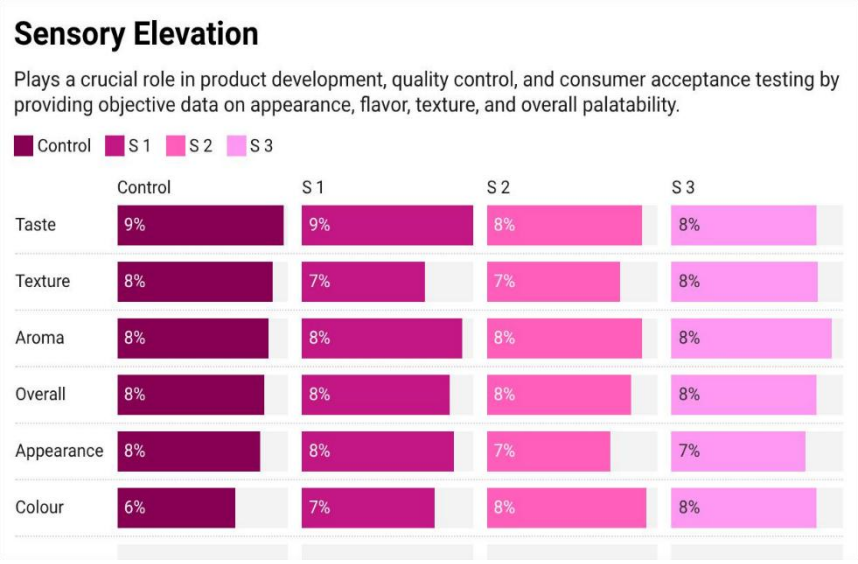

Figure 3: Depicted values of Sensory Evaluation

Most Preferred Sample: S1 (highest overall acceptability), mainly due to its taste and appearance.

Least Preferred Sample: S2, slightly lower overall score, mainly due to appearance and texture. Differences are relatively small, indicating all samples were generally acceptable.

6.1.Sensory Elevation:

Sensory evaluation was conducted on different formulated samples of tikki. Samples coded as S0 (Control), S1, S2, and S3.From the table and graph the results showed that all the samples had variation as evaluated by panelists. The sensory characteristics of the developed samples were evaluated by a panel of judges based on appearance, colour, texture, aroma, taste, and overall acceptability. The results showed that all the samples received favourable scores,

indicating good acceptance among the panelists. Sample S1 recorded the highest overall acceptability score (7.78), mainly due to its appealing appearance and superior taste. The control sample (S0) also performed well, particularly in terms of texture and taste, suggesting a familiar and desirable product quality. Sample S2 obtained the highest score for colour (8.4), which may be attributed to the presence of millet flour influencing the visual appeal of the product. Sample S3 received the highest score for aroma (8.5), indicating a pleasant flavour profile. Overall, the findings suggest that the incorporation of foxtail and barnyard millet flours contributed positively to the sensory properties, and the developed formulations were well accepted by the panelists.[Table 3, Figure 3]

6.2. Proximate analysis:

6.2.1. Moisture content:

Fig 4. (a) **Fig 4. (b)**

Fig 4. Moisture analysis of the samples (a) before and (b) after moisture reduction.

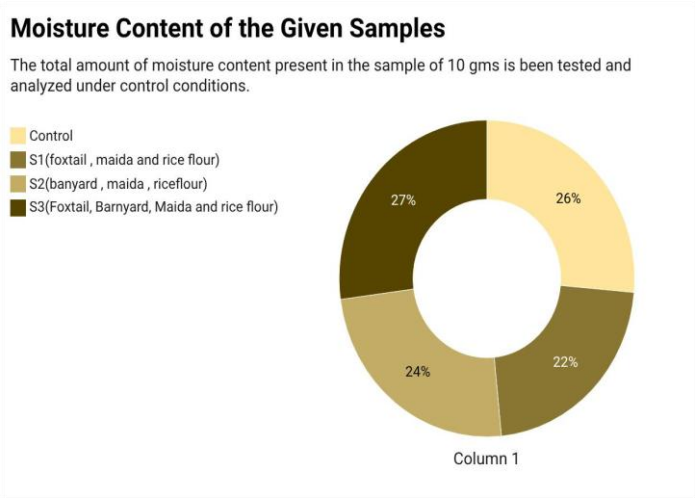

Fig 5: Graphical representation of Moisture Content values

The moisture content of the formulated bread samples showed slight variation among the different formulations. The control sample recorded a moisture content of 18.03%. Sample S1, prepared with foxtail millet, maida, and rice flour, showed the lowest moisture content at 15.32%. Sample S2, containing barnyard millet, maida, and rice flour, had a moisture content of 17.01%. The highest moisture content was observed in sample S3, formulated with foxtail

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millet, barnyard millet, maida, and rice flour, with a value of 18.85%. These variations in moisture content may be attributed to differences in the composition and water absorption capacity of the flours used in each formulation.[Table 4,Figure 4&5].

Table 4. Estimation of moisture & ash content

Sample	Moisture Content	Ash Content
Control	18.036%	2.35%
S1(foxtail , maida and rice flour)	15.32%	4.54%.
S2(banyard , maida , rice flour)	17.01%	4.27%
S3(foxtail, barnyard,maida and rice flour)	18.85%	5.23%

6.2.2. Ash content :

The ash content of the different bread samples showed variation depending on the formulation used. The control sample recorded the lowest ash content of 2.35%. Sample S1, prepared with foxtail millet, maida, and rice flour, showed a higher ash content of 4.54%. Sample S2, containing barnyard millet, maida, and rice flour, recorded an ash content of 4.27%. The highest ash content was observed in sample S3, formulated with foxtail millet, barnyard millet, maida, and rice flour, with a value of 5.23%. The increase in ash content in the formulated samples may be attributed to the higher mineral content present in millet flours compared to the control sample.[Table 4,Figure 6,7].

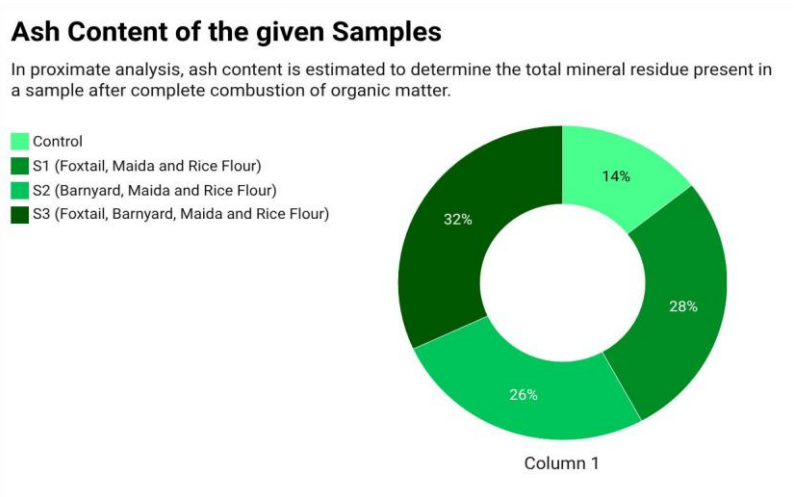

Figure 6: Graphical representation of Ash Content values

S1 has lowest moisture and highest ash content, making it nutritionally richer and potentially more shelf-stable. S2 has moderate moisture and high ash, also nutritionally enhanced. S3 has highest moisture and lowest ash content, which may affect shelf life and nutritional value. Control is intermediate in both attributes.

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Fig 7. Ash analysis of the samples in the muffle furnace.

6.2.3.Fat content :

The fat content of the different bread samples varied depending on the flour composition used in the formulations. The control sample prepared with maida and rice flour showed the highest fat content of 12.1%. Sample S1, formulated with foxtail millet, maida, and rice flour, recorded a fat content of 8.6%. Sample S2, containing barnyard millet, maida, and rice flour, showed a slightly lower fat content of 7.3%. The lowest fat content was observed in sample S3, which was prepared using foxtail millet, barnyard millet, maida, and rice flour, with a value of 6.68%. The reduction in fat content in the formulated samples may be attributed to the inclusion of millet flours in the formulation. [Table 5, Figure 8,9].

Table 5. Estimation of fat and fiber content

Sample	Fat Content	Fiber Content
Control (maida and rice flour)	12.1%	9%
S1(foxtail , maida and rice flour)	8.6%	7.85%
S2(banyard , maida , riceflour)	7.3%	9.54%
S3(foxtail, barnyard,maida and rice flour)	6.68%	11.21%

6.2.4. Fiber content:

The fiber content of the different bread samples showed noticeable variation among the formulations. The control sample prepared with maida and rice flour recorded a fiber content of 9%. Sample S1, formulated with foxtail millet, maida, and rice flour, showed a slightly lower fiber content of 7.85%. Sample S2, containing barnyard millet, maida, and rice flour, recorded a fiber content of 9.54%. The highest fiber content was observed in sample S3, prepared with foxtail millet, barnyard millet, maida, and rice flour, with a value of 11.21%. The increase in fiber content in sample S3 may be attributed to the combined inclusion of both millet flours, which are known to be good sources of dietary fiber.[Table 5, Figure 8,9].

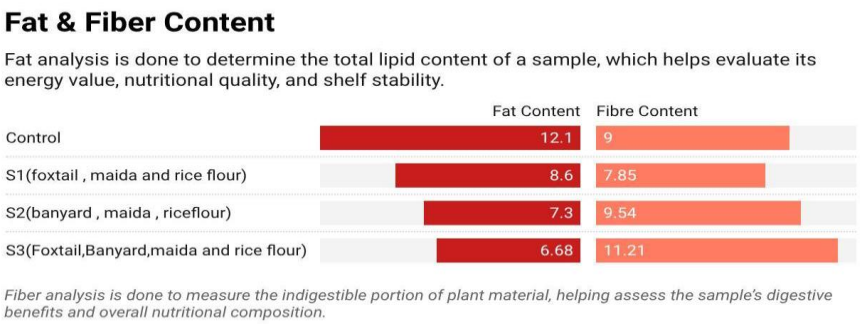

Figure 8: Analysis of Fat & Fiber Content values

Based on the analyses, S1 shows a good balance of sensory acceptability and moderate fat and fiber, S2 is the most fiber-rich and nutritious, Control is high in fat and moderate in other qualities, while S3 has the lowest nutritional value and higher moisture. Overall, S1 and S2 are the best samples, with S2 being healthier and S1 being more preferred in taste and overall acceptability.

Fig. 9 (a) **Fig. 9 (b)**

Fig. 9: Fat analysis of samples (a)during and (b) after the process.

7. Discussion:

The present study evaluated the development and quality characteristics of tikki prepared using barnyard millet and foxtail millet flour as primary ingredients. The findings demonstrate that millet-based tikki can serve as a nutritious and acceptable alternative to conventional cereal-based snack products. Sensory evaluation results revealed that the developed tikki formulations were well accepted in terms of taste, texture, aroma, and overall acceptability. Among the variations tested, the formulation with balanced proportions of barnyard and foxtail millet demonstrated the most desirable characteristics. The mild nutty flavor of foxtail millet combined with the light texture of barnyard millet contributed to a palatable product. However, higher levels of millet flour slightly affected the crispness and binding properties, which may be due to the absence of gluten.[11,12,13]

The texture profile analysis indicated that millet-based tikkis possess good structural integrity and crisp outer layers when shallow fried, although they may require suitable binders such as potato, chickpea flour, or other natural binding agents to improve cohesiveness. Similar

findings have been reported in previous studies where millet incorporation enhanced nutritional quality but required formulation adjustments to maintain product texture and sensory appeal.[13,14]

Overall, the results suggest that barnyard and foxtail millet tikki is a promising functional snack product that combines improved nutritional value with acceptable sensory qualities. The product has potential for commercialization as a healthy alternative to conventional fried snacks while also promoting the utilization of under-utilized millets in daily diets.[15,16]

8. Conclusion:

The study concluded that incorporating foxtail and barnyard millet flours into tikki significantly improves its nutritional quality by increasing fiber and mineral content while reducing fat [16]. Among the formulations, the foxtail millet sample (S1) showed the highest overall acceptability in terms of taste and appearance. All millet-based tikkis were well accepted, indicating that millet incorporation does not compromise sensory qualities. Therefore, millet tikki can be considered a healthy, gluten-free, and low glycemic snack with good potential for wider consumption and commercialization.

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